PROCESS OF GENERATING HIGH HYDROPHILICITY FOR ARTIFICIAL FIBER FABRIC

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a process of generating high hydrophilicity for an artificial fiber fabric, and more particularly to a process in which a plasma surface modification is employed to modify the surface an artificial fiber fabric and generate high hydrophilicity at its surface.

2. Description of the Prior Art

Market survey indicates that artificial fibers and natural fibers respectively share 50% of global fiber markets. Due to limitations in the molecular structure of artificial fibers, a fabric made of artificial fibers has poorer moisture absorption ability than that of a fabric made of natural fibers. In other words, an artificial fiber fabric is inherently hydrophobic. When the artificial fiber fabric is used in clothing, because of the hydrophobicity, sweat cannot be effectively and quickly absorbed by and evaporated via the fabric, causing discomfort on a wearer's body. It is therefore an important issue for the fabric industry to improve the hydrophilicity of the artificial fiber fabrics.

The followings are some well-known techniques currently employed by manufacturers to improve the hydrophilicity of artificial fiber fabrics, so that the fabrics show good moisture absorption ability and good evaporation ability of absorbed sweat or moisture:

1. Production of shaped fiber or hollow porous fiber: In the process of spinning, changes in the structure of spinning nozzle and/or addition of surfactant is executed to increase a surface ratio or a surface area of the produced artificial fiber, so that moisture on the surface of fiber quickly diffuses via capillary phenomenon to achieve moisture absorption.

However, the shaped fiber tends to deform and adversely affect its moisture absorption. Moreover, external particles attached to grooves on the surface of the shaped fiber in the process of dyeing and finishing largely reduce the moisture absorption and prevent the evaporation of absorbed moisture via the shaped fiber.

2. Treatment with hydrophilic agent: In the finishing treatment of an artificial fiber fabric, hydrophilic agent is added into a pressurized tank to spread over the fabric surface. A disadvantage of the hydrophilic agent treated fabric is an inferior washing resistance or washing fastness thereof. The hydrophilic agent treated fabric tends to lose its hydrophilicity after several times of washing.
3. Formation of multilayer texture structure: Natural fibers and artificial fibers are spun or woven into double or triple layer texture structure. A fabric of multilayer texture structure formed in this way has improved hydrophilicity but is produced with complicate technique and accordingly at increased manufacturing cost.

SUMMARY OF THE INVENTION

A primary object of the present invention is to provide a process for generating high hydrophilicity for an artificial fiber fabric to eliminate drawbacks existing in the conventional ways of producing hydrophilic artificial fiber fabrics.

Another object of the present invention is to provide an artificial fiber fabric that shows good moisture absorption ability and good evaporation ability of absorbed sweat. A process for forming this type of artificial fiber fabric includes a step of fiber surface modification to improve the hydrophilicity of the fabric.

A further object of the present invention is to provide a process for modifying an artificial fiber fabric with plasma, so that the treated fabric shows high moisture absorption and allows quick natural evaporation of the absorbed moisture.

BRIEF DESCRIPTION OF THE DRAWINGS

The method and the technical means adopted by the present invention to achieve the above and other objects can be best understood by referring to the following detailed description of the preferred embodiments and the accompanying drawings, wherein:

Fig. 1 is a schematic diagram showing a system for implementing the process of the present invention for generating high hydrophilicity for an artificial fiber fabric; and

Fig. 2 is a flowchart showing steps included in the process of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a new technique for generating excellent hydrophilicity for an artificial fiber fabric, such as nylon, polyester or mix woven fabric. In the process of the present invention, plasma is employed to modify the surface of an artificial fiber fabric, so that the modified fabric shows high moisture absorption and allows quick evaporation of the absorbed moisture. When the fabric treated with the process of the present invention is applied to clothing, sweat perspired by a wearer could be quickly absorbed by and naturally evaporated via the fabric to keep the wearer's body dry and fresh.

Please refer to Fig. 1 that is a schematic diagram showing a treatment system for implementing the process of the present invention to generate high hydrophilicity for an artificial fiber fabric. As shown, the treatment system mainly includes a closed tank 1, and a plasma exciter 2 and a gas source supplying device 3 connected to the closed tank 1. With the treatment system shown in Fig. 1, the present invention provides a plasma surface modification to treat an artificial-fiber fabric 4 for the same to show good hydrophilicity.

The fabric 4 to which the process of the present invention can be applied includes tatted fabrics, knitted fabrics, and non-woven fabrics

produced with artificial fibers, such as polyvinyl fiber, polypropylene fiber, polyester fiber, nylon fiber, acrylic fiber, etc., as well as mix-woven fabrics or mixture fabrics produced with any of the above-mentioned artificial fibers and any type of natural fibers.

In the process of the present invention, the fabric 4 to be treated is put in the closed tank 1, and a gas is supplied to the closed tank 1 from the gas source supplying device 3. By means of excitation of the plasma exciter 2, the gas is repeatedly transferred between high energy level and stable energy level, and emits photons. Plasma is a partially ionized gas that is composed of a large quantity of neutral gas and a small quantity of cations and electrons. When a neutral substance is applied with energy, such as a high temperature or accelerated electrons and/or accelerated ions, the neutral substance is excited, dissociated and ionized to produce plasma.

In the treatment system employed in the present invention, the plasma exciter 2 may include, for example, radio frequency plasma or microwave frequency plasma. Non-polymerized gas that may be used to produce the plasma-state gas includes argon (Ar), helium (He), nitrogen (N_2), oxygen (O_2), and ammonia gas (NH_3). Pressure in the closed tank 1 for the radio frequency plasma or the microwave frequency plasma to excite to the plasma state is ranged from atmospheric pressure to 30 mtorr. When the artificial fiber fabric 4 is subjected to surface modification by treating it with the plasma obtained from the ionized gas, it shows high moisture absorption and allows rapid natural evaporation of the absorbed moisture therefrom.

Fig. 2 is a flowchart showing steps included in the process of the present invention. In the processes, an artificial fiber fabric to be processed is first prepared (step 101). The prepared fabric is then put in a closed tank (step 102). A gas is supplied from a gas source supplying device into the closed tank (step 103). A plasma exciter is actuated to excite the gas supplied to the closed tank to repeatedly transfer between high energy level and stable energy level and form plasma (step 104). Surfaces of the fabric positioned in the closed tank are modified by the produced plasma and exhibit excellent hydrophilicity (step 105).

After the prepared fabric has been modified by the produced plasma for

1 to 120 seconds, the modified sample is analyzed with a surface analyzer. It is found a density of oxygen and nitrogen atoms on the surface of the treated fabric sample increases by 1 to 10%, as compared to an unmodified fabric sample.

When an unmodified fabric sample and a modified fabric sample are tested under the same conditions and environments for various moisture absorption and evaporation indexes thereof, the following differences between them are found:

1. The fabric sample modified by the plasma state gas has an absorbed moisture diffusion velocity of 0.5 to 50 seconds according to JIS L1096-1990.
2. The fabric sample modified by the plasma state gas has an absorbed moisture diffusion area that is 1 to 100 times larger than that of the unmodified fabric sample.
3. The fabric sample modified by the ionized plasma state gas has a capillary rise height that is 1 to 10 times higher than that of the unmodified fabric sample.
4. The fabric sample modified by the plasma state gas has an absorbed moisture evaporation rate that is 1 to 10 times higher than that of the unmodified fabric sample.

Before conducting various tests for the moisture absorption and evaporation indexes, all the fabric samples are dried at 120°C for 30 minutes to ensure complete removal of moisture from the samples to be tested. The dried samples are then positioned still under a room temperature of 22±2°C and a relative humidity of 65±10% for more than 24 hours. In this manner, the fabric samples to be tested may have moisture content within a reasonable range to avoid errors in the tests due to an overloaded high moisture content in the samples.

The following are some examples in which the process of the present invention is employed to improve the hydrophilicity of the artificial fiber fabric 4. It is understood these examples are only some applications rather than a complete scope of the present invention. In these examples, five different testing samples numbered from 1 to 5 are used. The testing

sample No. 1 is a plain tatted fabric produced with 100% nylon fiber and having a unit weight of 119g/m^2; the testing sample No. 2 is a twill tatted fabric produced with 100% polyester fiber and having a unit weight of 103g/m^2; the testing sample No. 3 is a satin tatted fabric produced with 45% polyester fiber and 55% nylon fiber and having a unit weight of 111g/m^2; the testing sample No. 4 is a twill tatted fabric produced with 100% nylon fiber and having a unit weight of 110g/m^2; and the testing sample No. 5 is a twill tatted fabric produced with 100% polyester fiber and having a unit weight of 103g/m^2. Surface modification of the above five testing samples is effectuated by treating them with different plasma state gases excited with high-frequency electric wave or microwave based on the process of the present invention.

Treatment conditions adopted in the five examples of the present invention are listed in the following Table I.

Table I

Sample No.	Plasma State Gas	Excitation Frequency	Excitation Power (W)	Operating Pressure (mtorr)	Time of Treatment (second)
Example 1	O_2	13.56 MHz	800	300	30
Example 2	NH_3	13.56 MHz	1000	300	30
Example 3	O_2	13.56 MHz	300	300	10
Example 4	Ar	13.56 MHz	300	300	30
Example 5	O_2	2.45 GHz	900	200	10

To find out the effect of the process of the present invention on the hydrophilicity of artificial fiber fabrics, the above five testing samples Nos. 1 to 5 having been treated with the present invention and three other untreated samples Nos. 1 to 3 for comparsion are tested for various moisture absorption and evaporation indexes thereof. The comparison sample No. 1 is a plain tatted fabric produced with 100% nylon fiber and having a unit weight of 119g/m^2; the comparison sample No. 2 is a twill tatted fabric produced with

100% polyester fiber and having a unit weight of 103g/m^2; and the comparison sample No. 3 is a satin tatted fabric produced with 45% polyester fiber and 55% nylon fiber and having a unit weight of 111g/m^2.

It is to be noted that all the above-mentioned testing samples and comparison samples are fabrics after dyeing and finishing treatment but not processed with any of the conventional techniques for improving the hydrophilicity thereof. That is, all the above samples are not produced with shaped or hollow porous fibers, not added with any hydrophilic agent, and not multilayer texture structure.

All the testing samples and comparison samples are dried at 120°C for 30 minutes, and then positioned still in a moisture-regain box for 24 hours. The moisture-regain box has a controlled relative humidity of 65±5% and a controlled temperature of 22±2°C. Thereafter, various tests for moisture absorption and evaporation indexes are conducted on these samples. The test results are shown in the following Table II.

Table II

Sample No.	Absorbed Moisture Diffusion Velocity (second)	Absorbed Moisture Diffusion Area (cm^2)	Capillary Rise Height (cm)	Absorbed Moisture Evaporation Rate (%)
Testing sample No.1	2.5	40.0	12.5	90
Testing sample No.2	3.2	50.1	10.2	75
Testing sample No.3	1.7	53.1	7.7	90
Testing sample No.4	2.0	41.3	12.5	78
Testing sample No.5	3.5	41.8	11.6	90
Comparison sample No.1	124	12.4	4.4	25
Comparison sample No.2	>600	17.2	4.3	40
Comparison sample No.3	108	2.2	1.7	40

To ensure the precision of test, all the tests are conducted under specific environments with controlled relative humidity and temperature. That is, the test results shown in Table II are obtained with the testing temperature maintained at 22±2°C and the relative humidity controlled at 65±5%. Wherein, the absorbed moisture diffusion velocity test is conducted in accordance with JIS L1096-1990 6.26A; the capillary rise height test is conducted in a longitudinal direction in accordance with JIS L1096-1990 6.261B; the absorbed moisture diffusion area test is conducted by dripping 0.2 ml of distilled water on a testing sample fabric from a position 5cm above the sample fabric and measuring the diffusion area of the dripped water after 30 seconds; and the absorbed moisture evaporation rate is tested by preparing and weighing a sample fabric of 10cm x 10cm in size, dripping 1.0 ml of distilled water on the sample fabric, positioning the sample fabric still in a chamber maintained at constant temperature and relative humidity for 10 minutes, and weighing the sample fabric again to calculate the absorbed moisture evaporation rate thereof.

From the test results of the above examples applying the process of the present invention, it is proven the artificial fiber fabrics treated with the process of the present invention are indeed improved in their hydrophilicity to show quick moisture absorption and allow rapid natural evaporation of the absorbed moisture. The process of the present invention for generating high hydrophilicity for an artificial fiber fabric is therefore industrially practical for use.

Although the present invention has been described with reference to the preferred embodiments and the best mode of operation thereof, it is apparent to those skilled in the art that a variety of modifications and changes may be made without departing from the scope of the present invention which is intended to be defined by the appended claims.